Method of 3d solar energy conversion.

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We have study experimentally the problem of collecting solar energy and make their efficiency higher. It was discovered than a three-dimensional photovoltaic 3DPV structures can generate measured energy densities higher by a factor of 2–20 than stationary flat PV panels. We have found that the same structures work better not only because it made in 3D. We have found PV panels have not linear dependency from geometry. It seems that the conversion efficiency depends on the process of absorption of the solar energy too or in other words on the E. Yablonovich limit. Our findings suggest that quantity of material of solar panels may be decreased for generation same electricity.

The Sun is the ultimate source of energy that sustains all life. The Sun expose the Earth with enough solar energy in one hour to power the entire world for one year. If we can capture a small portion of this energy and cost-effectively convert it into useful electricity, then we can inhabit the Earth for as long as the Sun exists without worrying about a shortage of energy. This single fact has propelled the solar industry on a path of exponential growth.

Converting the solar flow into affordable electricity is an enormous challenge. The main barriers to widespread adoption of PV technology include system costs (3–5 $/Watt-peak) of which ~60% is due to installation costs, the limited number of peak insolation hours available in most locations.

The main approach applied so far to alleviate these problems has been to search for lower-cost active layers with higher power conversion efficiencies. However, efficiency improvements can only partially reduce the installation costs and cannot change the pattern of solar energy generation, since these aspects are related to the PV system design.

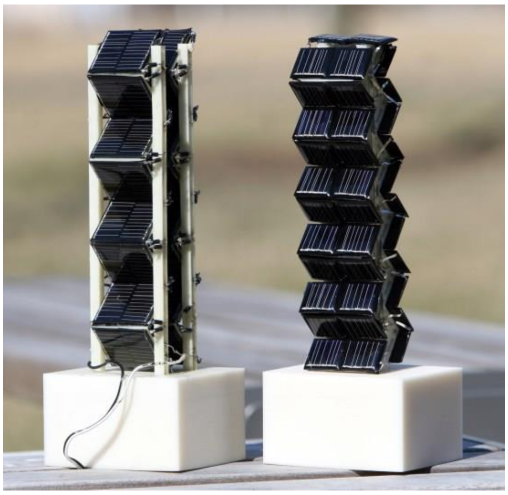

Fig. 1. Three-dimensional photovoltaic structure.

Marco Bernardi et al [1] formulate, solve computationally and study experimentally the problem of collecting solar energy in three dimensions. They demonstrate that absorbers and reflectors can be combined in the absence of sun tracking to build three-dimensional photovoltaic (3DPV) structures that can generate measured energy densities (energy per base area, kWh/m^2) higher by a factor of 2–20 than stationary flat PV panels. For the structures considered there, they compared to an increase by a factor of 1.3–1.8 for a flat panel with dual-axis sun tracking. The increased energy density is countered by a larger solar cell area per generated energy for 3DPV compared to flat panels (by a factor of 1.5–4 in our conditions), but accompanied by a vast range of improvements. Authors wrote 3DPV can double the number of peak power generation hours and dramatically reduce the seasonal, latitude and weather variations of solar energy generation compared to a flat panel design.

Fig.2. Dielectric core-shell optical antennas.

Yiling U et al [2] demonstrate a new light trapping technique that exploits dielectric core–shell optical antennas to strongly enhance solar absorption. This approach can allow the thickness of active materials in solar cells lowered by almost 1 order of magnitude without scarifying solar absorption capability. They investigate the fundamental mechanism for this enhancement multiplication and demonstrate that the size ratio of the semiconductor and the dielectric parts in the core–shell structure is key for optimizing the enhancement.

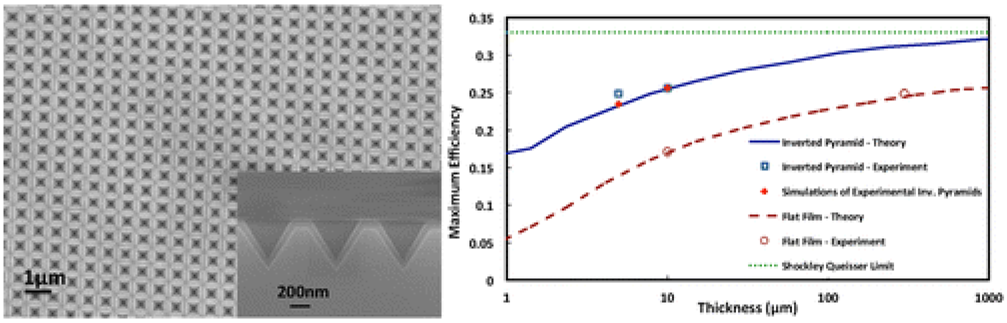

Fig.3. Inverted nanopyramid light-trapping scheme for c-Si thin films

Anastassios Mavrokefalos et al [3] approve thin-film crystalline silicon (c-Si) solar cells with light-trapping structures can enhance light absorption within the semiconductor absorber layer and reduce material usage. They demonstrated that an inverted nanopyramid light-trapping scheme for c-Si thin films, fabricated at wafer scale via a low-cost wet etching process, significantly enhances absorption within the c-Si layer. A broadband enhancement in absorptance that approaches the Yablonovitch limit [4] is achieved with minimal angle dependence.

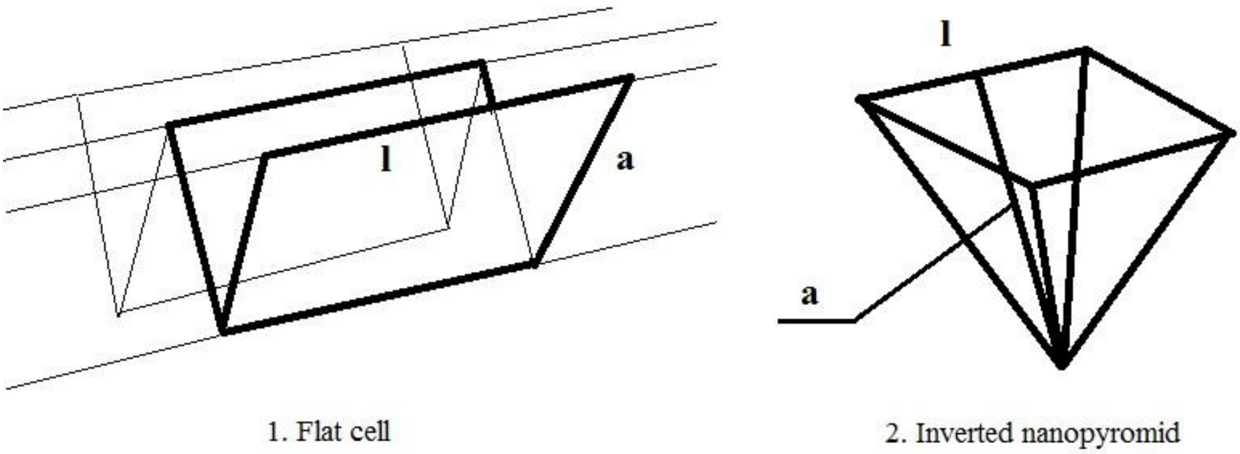

Fig.4. 1. Flat cell texture and 2. Inverted nanopyramid.

We have calculated that the surface of nanopyramid (S_p) and surface of a part of hatching (S_l) with same linear dimensions are equal.

$$S_p=p*a/2 \quad (1)$$

where:

p - perimeter.

a - apothem.

$$S_l=2*a*l \quad (2)$$

where:

a - apothem.

l - lenght.

l=p/4 and we may replace l and p/4, so:

$$S_l=2*a*p/4=p*a/2=S_p \quad (3)$$

As we can see Sp and Sl is equal. Fabricating of the nanopyramides on the solar cell surface is complex and expensive process. We may simply manufactured scratched solar cells with higher efficiency.

So, in summary of sentences above we have guessed a way of improving solar cell's efficiency. It seems to be better to use a ratio of visible and whole square of solar cell to make it better. In accordance to this idea, we build a new angular PV converter.

It is a device with at least two solar cells placed opposite and oriented of wide end to a sun. It is two couples of solar cells one (external) is horizontally oriented and another (internal) is set with angle between cells each of it connected sequential. Results of testing of the experimental device presented in the Tab.1. Solar cell dimensions: length - 150 mm, width - 80 mm.

Tab.1.

Geometry	Power Watts
Horizontally oriented	0.19
Angle between cells	0.40

We have tested the dependence of power of solar cell and its geometry (Fig.6.). An analysis of it show non-linear dependence of absorption of photons.

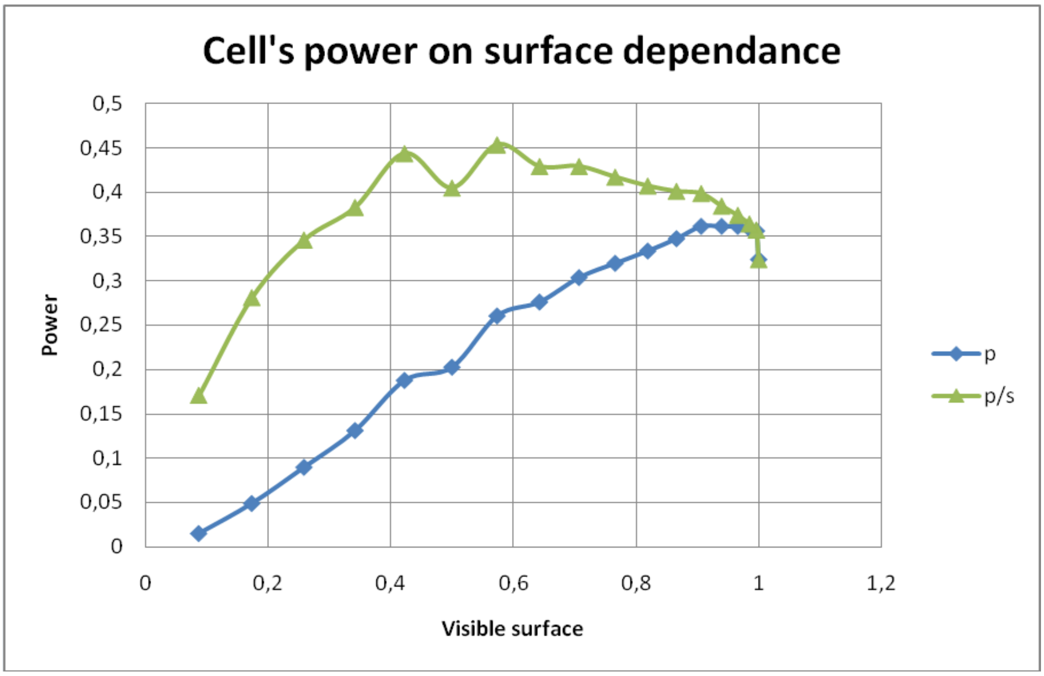

Fig.6. Power productivity of solar cell.

p - power of cell, p/s - power per area of lighting.

We increased power of solar cell twice. It can generally apply to a wide range of inorganic and organic active materials. 3D solar cells that capture nearly all of the light that strikes them and could boost the efficiency of photovoltaic systems while reducing their size, weight and mechanical complexity.

Conclusions:

We guess that the efficiency of PV conversion depend on the ratio of visible and whole square of solar cell. Here we demonstrate that a focline is better than an inverted nanopyramid light trapping. The focline can be fabricate at the any process, enhances absorption within the any type of solar cell. The way we tested is a cheapest way to improve the solar cell's technology.

References:

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